

**We claim:**

1. A mixed-signal monitoring system comprising:  
an analog-to-digital converter (ADC); and  
5 a temperature sampler circuit, wherein the temperature sampler circuit comprises a first PN-junction coupled directly to the ADC ;  
wherein the temperature sampler circuit is operable to generate a temperature voltage signal ( $\Delta V_{BE}$ ) proportional to a temperature of the first PN-junction;  
wherein  $\Delta V_{BE}$  represents a change in voltage across the first PN-junction; and  
10 wherein the ADC is operable to:  
amplify the  $\Delta V_{BE}$  signal, resulting in an amplified  $\Delta V_{BE}$  signal;  
subtract an offset voltage from the amplified  $\Delta V_{BE}$  signal; and  
output a digital numeric value representative of the temperature of the first  
PN-junction.  
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2. The mixed-signal monitoring system of claim 1, wherein the first PN-junction is a diode.
3. The mixed-signal monitoring circuit of claim 1, wherein the first PN-junction is  
20 derived from a transistor.
4. The mixed-signal monitoring system of claim 1, wherein the first PN-junction and the ADC are comprised on one integrated circuit.
- 25 5. The mixed-signal monitoring system of claim 1 further comprising a voltage sampler circuit coupled to the ADC, wherein the voltage sampler circuit is operable to:  
receive and sample one or more of:  
a single-ended input voltage; and  
a differential input voltage;  
30 generate a differential output voltage; and

provide the differential output voltage to the ADC .

6. The mixed-signal monitoring system of claim 5 further comprising a voltage multiplexer circuit operable to selectively couple one of a plurality of available single-ended input voltages to the voltage sampler circuit.

7. The mixed-signal monitoring system of claim 5 further comprising an enable circuit operable to:

selectively enable the voltage sampler circuit during a voltage monitoring mode;  
and

selectively enable the temperature sampler circuit during a temperature monitoring mode.

8. The mixed-signal monitoring system of claim 5, wherein the ADC comprises:

an amplifier having an input and an output;

a reference input-capacitor circuit coupled to the amplifier and configured to selectively decrease voltage at the output of the amplifier by a reference voltage amount;

an offset-reference input-capacitor circuit coupled to the amplifier and configured to decrease voltage at the output of the amplifier by an offset voltage amount;

a temperature-mode input-capacitor circuit operable to couple the first PN-junction to the input of the amplifier;

a voltage-mode input-capacitor circuit operable to couple the voltage sampler circuit to the input of the amplifier;

a circuit selection device;

a comparator circuit coupled to the output of the amplifier; and

an output filter coupled to an output of the comparator circuit;

wherein the output of the comparator circuit is coupled to a respective input of the reference input-capacitor circuit;

wherein the circuit selection device is operable to couple the amplifier circuit to:

the temperature-mode input-capacitor circuit during the temperature monitoring mode; and

the voltage-mode input-capacitor circuit during the voltage monitoring mode.

9. The mixed-signal monitoring system of claim 8, wherein the temperature sampler  
5 circuit further comprises:

a second PN-junction and a third PN-junction, each coupled to respective inputs of the temperature-mode input-capacitor circuit; and

a current supply comprising a first current source and a second current source;

10 wherein the first current source is applied to the second PN-junction resulting in a second-PN-junction voltage, and the second current source is applied to the third PN-junction resulting in a third-PN-junction voltage; and

wherein a multi-phase switching device is operable to alternately:

apply the first current source to the first PN-junction during a first phase;

15 and

apply the second current source to the first PN-junction during a second phase;

wherein switching between the first phase and the second phase results in the change in voltage across the first PN-junction; and

20 wherein a difference between the second-PN-junction voltage and the third-PN-junction voltage is commensurate with the change in voltage across the first PN-junction.

10. The mixed-signal monitoring system of claim 9, wherein current supplied by the first current source is an integer multiple of current supplied by the second current  
25 source.

11. A temperature-to-digital converter system, the system comprising;

an amplifier comprising a first input, a second input, a first output and a second output;

30 a plurality of PN-junctions comprising a first PN-junction, a second PN-junction, and a third PN-junction;

a plurality of capacitors comprising a first input capacitor, a second input capacitor, a third input capacitor, a fourth input capacitor, a first feedback capacitor, a second feedback capacitor, a third feedback capacitor, and a fourth feedback capacitor;

5 a current supply comprising a first current source, a second current source, a third current source and a fourth current source;

a first switch and a second switch;

a reference voltage capacitor network coupled to the first input and the second input;

10 an offset reference voltage capacitor network coupled to the first input and the second input;

a comparator coupled to the first output and second output; and

an output filter coupled to the comparator;

15 wherein a first terminal of the first PN-junction is coupled to the first input through the first input capacitor, and a second terminal of the PN-junction is coupled to the second input through the second input capacitor;

wherein the third current source is applied to the second PN-junction, and the fourth current source is applied to the third PN-junction;

wherein the first switch is operable to:

20 couple an output common mode voltage ( $V_{cmo}$ ) to the first input through the third input capacitor;

couple the first input to the first output through the third feedback capacitor;

couple  $V_{cmo}$  to the second input through the fourth input capacitor;

25 couple the second input to the second output through the fourth feedback capacitor; and

apply the first current source to the first PN-junction;

wherein the second switch operable to:

couple the second PN-junction to an input common mode voltage ( $V_{cmi}$ ) through the third input capacitor;

30 couple the first input to the first output through the first feedback capacitor;

couple the third PN-junction to the  $V_{cmi}$  through the fourth input capacitor; and

couple the second input to the second output through the second feedback capacitor; and

5                    apply the second current source to the first PN-junction;

wherein the first switch is closed when the second switch is open, and the second switch is closed when the first switch is open; and

wherein the output filter is operable to output a digital numeric value representative of a temperature of the first PN-junction.

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12.    The system in claim 11, wherein the amplifier, the plurality of capacitors, the first switch, the second switch, the reference voltage capacitor network, the comparator, and the output filter are comprised in an ADC.

15    13.    The system in claim 12, wherein the first switch is controlled by a first clock signal, and the second switch is controlled by a second clock signal;

wherein the first clock signal and the second clock signal are non-overlapping clock signals.

20    14.    The system in claim 11;

wherein current provided by the first current source is equal to current provided by the third current source;

wherein current provided by the second current source is equal to current provided by the fourth current source; and

25                    wherein the current provided by the first current source is an integer multiple of the current provided by the second current source.

15.    The system of claim 11, wherein the first PN-junction, the second PN-junction and the third PN-junction are comprised on one integrated circuit.

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16. The system of claim 11, wherein the system is comprised on one integrated circuit.

17. A mixed-signal monitoring system comprising:

5 a switched-capacitor integrator;  
a first PN-junction coupled to the switched-capacitor integrator;  
a comparator coupled to an output of the switched-capacitor integrator;  
a decimation filter coupled to an output of the comparator; and  
a current-switching device alternately applying a first current and a second current  
10 to the first PN-junction for providing a  $\Delta V_{BE}$  of the first PN-junction to the input of the switched-capacitor integrator;

wherein an output of the comparator is coupled to an input of the switched-capacitor integrator, thereby forming a feedback loop;

15 wherein the switched-capacitor integrator is operable to output a voltage signal representative of a temperature of the first PN-junction; and

wherein the decimation filter is operable to output a digital numeric value representative of the temperature of the first PN-junction.

18. The mixed-signal monitoring system of claim 17;

20 wherein the switched-capacitor integrator is configured as an auto-zeroed switched-capacitor integrator and comprises a first input capacitor path, a second input capacitor path, a first charge replacement path, and a second charge replacement path;

25 wherein a first terminal of the first PN-junction is coupled to an input of the first input capacitor path and a second terminal of the first PN-junction is coupled to an input of the second input capacitor path;

wherein the first terminal of the PN-junction is further coupled to an input of the second charge replacement path and the second terminal of the first PN-junction is further coupled to an input of the first charge replacement path;

30 wherein an output of the first charge replacement path is coupled to an output of the first input capacitor path and an output of the second charge replacement path is coupled to an output of the second input capacitor path; and

wherein the  $\Delta V_{BE}$  of the first PN-junction is measured between the first terminal of the PN-junction and the second terminal of the PN-junction.

19. The mixed-signal monitoring system of claim 17 further comprising a second PN-junction and a third PN-junction;

wherein the switched-capacitor integrator is configured as an auto-zeroed switched-capacitor integrator and comprises an input capacitor path, a first charge replacement path, and a second charge replacement path;

wherein the second PN-junction is coupled to the first charge replacement path and the third PN-junction is coupled to the second charge replacement path;

wherein the first PN-junction is coupled to the input capacitor path;

wherein a third current is applied to the second PN-junction resulting in a junction-voltage ( $V_{BE}$ ) across the second PN-junction, and a fourth current is applied to the third PN-junction resulting in a  $V_{BE}$  across the third PN-junction;

wherein a voltage difference between the  $V_{BE}$  across the second PN-junction and the  $V_{BE}$  across the third PN-junction is commensurate with the  $\Delta V_{BE}$  of the first PN-junction.

20. The mixed-signal monitoring system of claim 17, wherein the switched-capacitor integrator, the comparator and the decimation filter are configured in an ADC.

21. A method for temperature-to-digital conversion, the method comprising:

obtaining a  $\Delta V_{BE}$  of a first PN-junction representative of a temperature of the first PN-junction;

amplifying the  $\Delta V_{BE}$  of the first PN-junction resulting in an amplified  $\Delta V_{BE}$  of the first PN-junction;

subtracting an offset voltage from the amplified  $\Delta V_{BE}$  of the first PN-junction resulting in a temperature voltage signal;

converting the temperature voltage signal to a digital numeric value and outputting the digital numeric value;

wherein said amplifying, said subtracting and said converting are collectively performed by an ADC.

22. The method of claim 21, wherein said obtaining the  $\Delta V_{BE}$  of the first PN-junction  
5 comprises alternately applying a first current and a second current to the first PN-junction.

23. The method of claim 21, wherein the ADC is a delta-sigma ADC comprising an  
10 auto-zeroed switched-capacitor integrator circuit.

24. The method of claim 23, wherein said obtaining the  $\Delta V_{BE}$  of the first PN-junction  
comprises alternately applying a first current and a second current to the first PN-junction;

wherein said applying the first current is performed during a sampling phase of  
15 the auto-zeroed switched-capacitor integrator circuit; and

wherein said applying the second current is performed during an integration phase  
of the auto-zeroed switched-capacitor integrator circuit.

25. The method of claim 24, wherein said amplifying includes:  
20 applying the first current to a second PN-junction resulting in a  $V_{BE}$  across the  
second PN-junction, and providing the  $V_{BE}$  across the second PN-junction to a first input  
of the auto-zeroed switched-capacitor integrator circuit;

applying the second current to a third PN-junction resulting in a  $V_{BE}$  across the  
third PN-junction, and providing the  $V_{BE}$  across the third PN-junction to a second input  
25 of the auto-zeroed switched-capacitor integrator circuit;

wherein a voltage difference between the  $V_{BE}$  across the second PN-junction and  
the  $V_{BE}$  across the third PN-junction is commensurate with the  $\Delta V_{BE}$  signal.

26. The method of claim 21, wherein the ADC is a pipeline ADC.  
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27. The method of claim 21, wherein the ADC is a cyclic ADC.